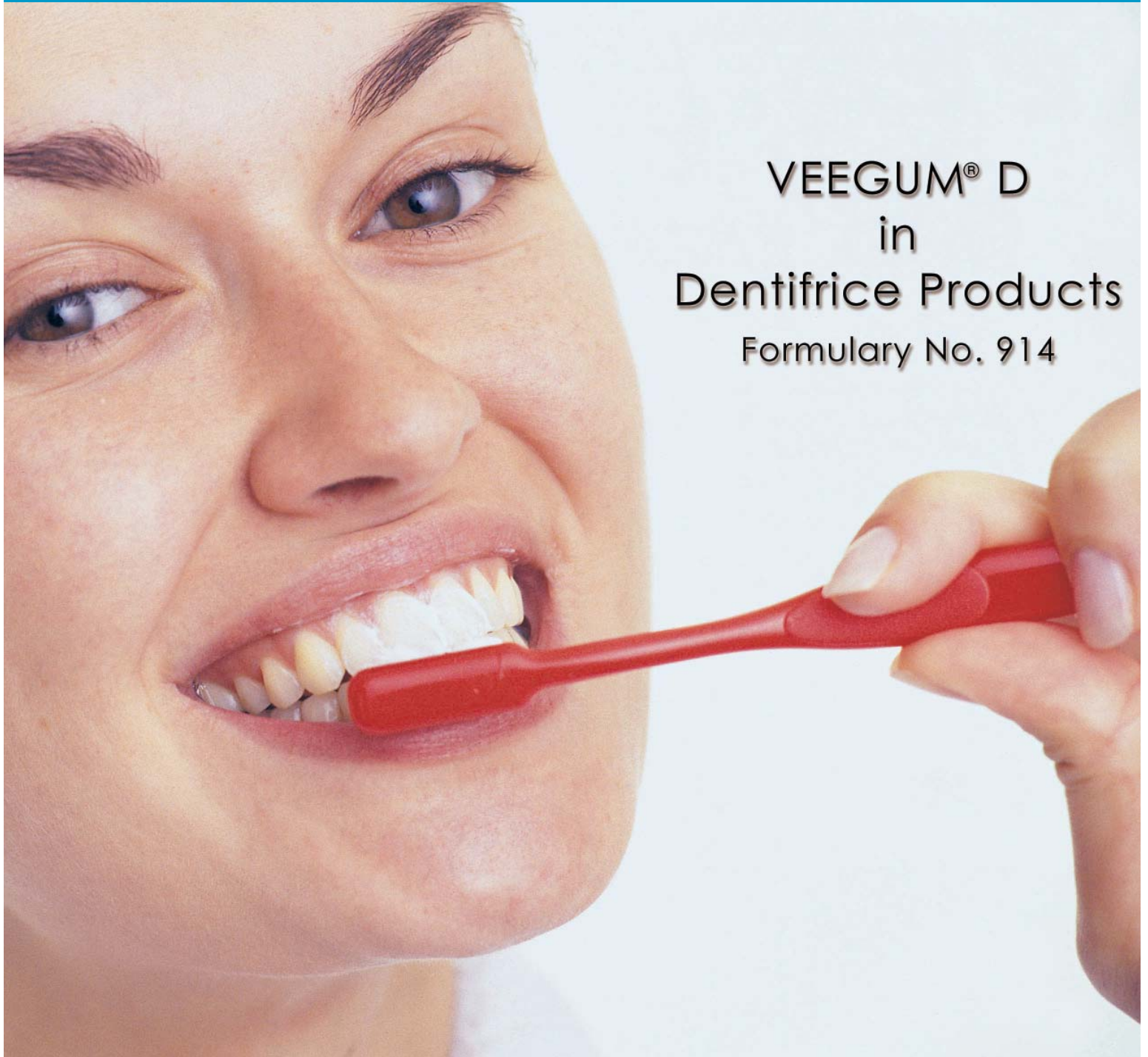




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VANDERBILT *Report*



VEEGUM® D
in
Dentifrice Products
Formulary No. 914

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High purity natural smectite clays have for many years been used as dentifrice binders. Certain smectites are avoided, however, in products containing sodium fluoride, because they can reduce fluoride activity. Fluoride bioavailability is compromised by reaction with residual calcium introduced with these clays. **VEEGUM D** is the preferred smectite binder because it can be used to optimize rheological and esthetic properties of the dentifrice with minimal fluoride tie-up. In addition, soluble pyrophosphate will ensure maximum fluoride effectiveness when incorporated into dentifrice preparations directly after the smectite.

Dentifrice Binders

A dentifrice binder is primarily required to ensure a uniform and stable mixture of all formula ingredients. It must stabilize the dentifrice against the separation of liquid and solid phases, even at temperature extremes. It must also maintain the product's paste or gel consistency, while allowing it to be shear-thinning. The dentifrice should be easily extruded from the tube or pump, but thick enough to sit on the toothbrush bristles, rather than sinking through them. The extruded ribbon of paste or gel should also thin out, disperse and foam readily when subjected to the shear of brushing.

The binder should likewise provide a "short" rather than stringy product. Once the ribbon is extruded onto the brush, it should break cleanly and abruptly as the dispenser is withdrawn. In addition to the above criteria, the binder must be compatible with fluorides and other therapeutic ingredients, and it should not detract from product color, flavor release or rinseability.

The binder plays a significant role in the consumer's perception of dentifrice quality, ease of use, sensory appeal, and efficacy. If the product appears wet, runny, stringy or discolored, if it tastes bland, feels gritty or is gummy in use, the consumer will be less likely to buy it again, regardless of its effectiveness as a tooth cleaner.

Because of the demands placed on the binder, dentifrice products today typically use a binder system instead of a single binder. Two or more materials are used in combination to optimize all aspects of binder performance.

Fluoride Activity and Smectite Clays

The extent to which a smectite clay will reduce fluoride availability from sodium fluoride dentifrices is determined by two factors. The major consideration is the amount of calcium introduced incidentally with the clay. Less significant is the slightly cationic nature of the edges of the smectite clay platelet.

The faces of each colloidal smectite particle carry a negative charge because of substitutions (e.g., Mg^{2+} for Al^{3+}) within the mineral lattice. Edges carry a slight positive charge due to lattice discontinuities. The net negative charge of the platelet is balanced mostly by sodium ions.

Calcium (Ca^{2+}) and other inorganic cations can be present in minor amounts. These charge-balancing ions are considered exchangeable because they can be readily substituted by other cations. Calcium may also become available from residual calcite (calcium carbonate) or dolomite (calcium magnesium carbonate) that remains in some clays even after beneficiation.

When sodium fluoride is used as the therapeutic ingredient, calcium adversely affects fluoride bioavailability due to the precipitation of calcium fluoride (CaF_2). The cationic nature, albeit slight, of the clay particle edges can ionically attract F^- and thereby also reduce bioavailability, although to a much smaller degree.

The most significant factor in the reduction of fluoride activity is the content of residual carbonate minerals, rather than the amount of exchangeable calcium ion. Carbonate minerals are commonly associated with trioctahedral smectites such as saponite and hectorite. Even after rigorous hydrothermal beneficiation, small amounts of these carbonates can remain in the clay. Reduction in fluoride recovery is generally proportional to carbonate content.

VEEGUM D and Maximum Fluoride Availability

Since Magnesium Aluminum Silicate N.F. products, the smectites traditionally used as dentifrice binders, are required to be blends of montmorillonite (typically carbonate-free) and saponite in various ratios, these products are usually contraindicated for use with sodium fluoride. **VEEGUM D**, a water-washed smectite clay, is produced solely from montmorillonite ores, and is designed to have minimal effect on fluoride availability.

Because **VEEGUM D** is produced from natural clay ores, its calcium content is not fixed but varies within a narrow range. Chemisorption of small amounts of fluoride is therefore still possible. However, research has shown that all interference with fluoride bioavailability is easily prevented by the use of water-soluble phosphate compounds, such as tetrapotassium pyrophosphate (TKPP) and tetrasodium pyrophosphate (TSPP), which are otherwise commonly employed in dentifrice products as anticalculus agents. When added to smectite dispersions before the introduction of sodium fluoride, these phosphates are believed to sequester Ca^{2+} , thus preventing the precipitation of CaF_2 .

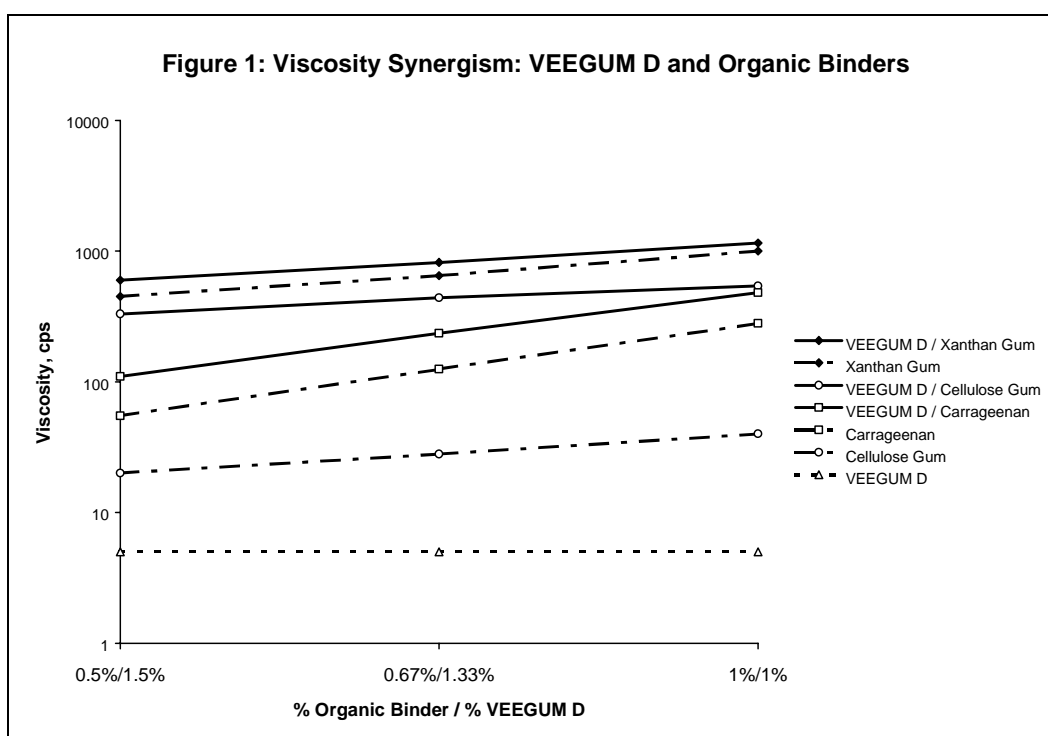
Soluble phosphates, particularly TSPP and TKPP, have been recognized for many years as efficient peptizing agents when added to dispersions of smectite clays. In this capacity the phosphate anion is attracted to the slightly cationic edges of the clay platelets. This inhibits the formation of the cohesive colloidal structure which normally provides characteristic rheological properties through the attraction of the slightly positive-charged platelet edges to the negative-charged platelet faces. Peptized dispersions therefore remain very fluid. The attraction of phosphate anion to clay platelet edges likewise leaves these edges unavailable to F^- , further promoting maximum fluoride availability.

VEEGUM D for Binder Performance

The colloidal structure of smectite clays is insensitive to temperature extremes, prevents gumminess or tackiness, and promotes shortness on dentifrice extrusion. Consequently, these clays have often been used in combination with organic binders that have high thickening efficiency, in order to counter the stringy, gummy, tacky and high temperature thinning nature of these gums. The incorporation of most smectite clays, however, involves the investment of more time or energy than required for organic binders, and in some formulations there is simply not enough water available in which to hydrate the clay.

VEEGUM D provides all the benefits of the traditional clay binders together with simplicity in use. **VEEGUM D** requires minimal energy and thus minimal time for incorporation during dentifrice production. Hydration is complete when a thin film of the clay dispersion shows no visible particles. This can often be accomplished with no more than 30 minutes of hydration. **VEEGUM D** can also be effectively hydrated at concentrations well beyond that of most smectite binders. Pumpable dispersions at 10% solids or higher, depending upon mixing equipment, are possible. This allows its use even in systems with low water content.

VEEGUM D is synergistic and broadly compatible with organic binders. This is used to advantage in optimizing the rheological, stability and esthetic properties of pastes and gels. Figure 1 provides examples of the viscosity synergism obtained with **VEEGUM D** and the common organic binders xanthan gum (**VANZAN**TM **NF**; R.T. Vanderbilt Company), carrageenan (Viscarin[®] TP 339; FMC Corporation) and cellulose gum (CMC 7MF; Aqualon).



VEEGUM D in Sodium Fluoride Toothpaste

Figure 2 provides an example of a toothpaste that maintains full fluoride availability. The binder system is based on the synergistic combination of **VEEGUM D** with **VANZAN NF** xanthan gum and cellulose gum. For optimum fluoride stability, the phosphate is added after the clay is dispersed and before any other ingredients are added. In this way, the clay is prevented from tying up any of the subsequently added fluoride. The phosphate also peptizes the clay. This allows the preparation of high solids dispersions, so that an effective amount of **VEEGUM D** can be used even in “lean” formulations — those with considerably less free water than the example in Figure 2. The peptized clay is not prevented, however, from performing synergistically with the co-binder gums.

Figure 2: Fluoride-Stable Toothpaste Prototype with VEEGUM D

Formula:	% by Weight
VEEGUM D	1.50
Water	41.11
Tetrasodium Pyrophosphate	1.00
Titanium Dioxide	0.30
VANZAN NF (Xanthan Gum; R.T. Vanderbilt)	0.80
CMC 7HF (Cellulose Gum; Aqualon)	0.30
Methyl Paraben	0.20
Propyl Paraben	0.05
Sorbitol, 70%	10.00
Glycerin	10.00
Zeodent [®] 113 (Hydrated Silica; Huber)	30.00
Saccharin	0.20
Water	2.80
Sodium Fluoride	0.24
Rhodapon [®] LSB (SLS. 29%; Rhodia)	1.50
Fluoride Assay:	
When prepared	1080 ppm
3 months at RT	1080 ppm
3 months at 45°C	1080 ppm

Conclusion:

VEEGUM D is the preferred dentifrice binder because it ensures a stable and short paste or gel, regardless of temperature, with excellent brush stand-up, flavor release and rinseability. It works synergistically with organic gum binders, allowing the fine-tuning of dentifrice properties with minimal inhibition of fluoride recovery. The incorporation of soluble pyrophosphate with **VEEGUM D** maximizes fluoride bioavailability.

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